GENESIS OF WINTER WEATHER OVER WEST TEXAS

J. A. CARR

WBAN Analysis Center, U. S. Weather Bureau, Washington, D. C.

INTRODUCTION

During the first week of November 1951, a large, cold Low, with a closed center extending to the 200-mb. level, dominated the free air circulation over the eastern half of the United States. This Low, which was elongated to the north and south of the center, lay approximately along the 82d meridian at the 500-mb. level on November 5. Generally speaking, it overlay the Hudson Bay region. (See the preceding article by Klein).

Shallow trough lines formed southwest, or west, from a center (in the major trough) west of James Bay, and moved into the United States from south-central Canada. One such trough on the evening of the 4th, moved southeastward out of Wyoming; it was associated with a snowstorm and two other phenomena whose origins were not immediately apparent.

One effect was the cold weather over the South Central and Gulf States, while the second was the formation of a large inverted "V" ridge of high pressure with a center over west Texas. What made these features interesting was the finding that they did not move directly into the South from the region of Canada, as usually happens. The discussion of these findings fills the major portion of this article. A remaining portion reports on the snowstorm which moved up the Mississippi Valley.

THE AIR FLOW AT THE 500-MB. LEVEL

Early on November 5, a previous surge of cold air was moving off the Atlantic Coast of the United States. At the 500-mb. level the isotherms and contour lines were parallel over the eastern half of the country with strong westerly winds (50 knots or more) over a large portion of the area east of the 95th meridian. So it seemed that the eastern portion of the United States would enjoy a respite from the cold weather which had invaded the length of the Mississippi Valley on the 3d of the month. However, the early morning map for November 5 revealed a developing trough along a line from Huron, S. Dak., through Goodland, Kans., to Albuquerque, New Mex.

The map that evening showed a closed circulation above Wichita, Kans. During the next 24 hours this Low moved toward Columbia, Mo., and then northeastward to a position west of Rantoul, Ill., on November 7 (fig. 1). This development appreciably altered the isotherm arrangement permitting north and south transport of the contrasting air masses. The southward dip of the isotherms over the southwestern plains signified the movement of cold air toward Texas and the Gulf of Mexico. In the following two days, the Low moved northeastward while the isotherm orientation returned to west-east over the eastern half of the country.

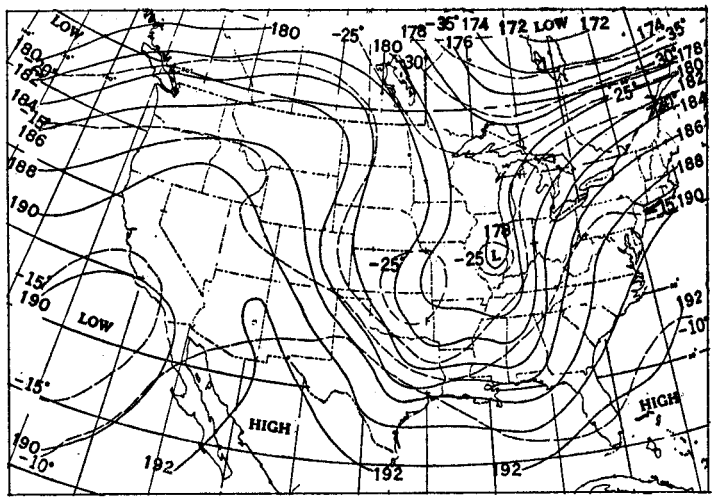

FIGURE 1.—500-mb. chart for 0300 GMT, November 7, 1951. Contours (solid lines) at 200 foot intervals are labeled in hundreds of geopotential feet. Isotherms (dashed lines) are at intervals of 5° C.

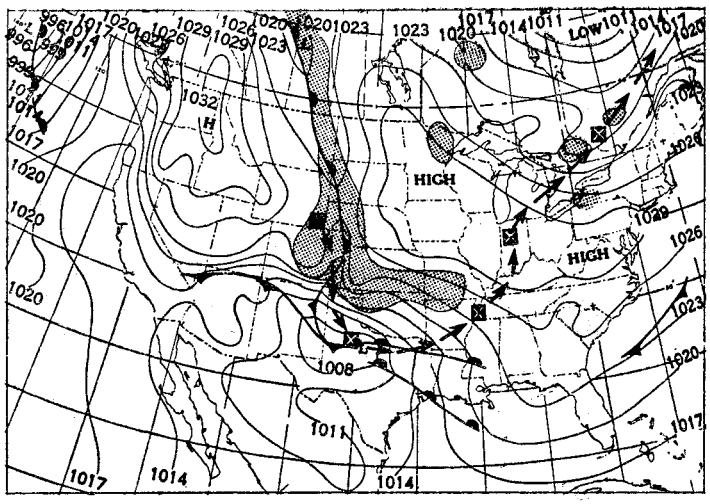

FIGURE 2.—Surface weather chart, 1230 GMT, November 5, 1951. Shading indicates areas of active precipitation. Arrows indicate path of Low. Blocked "X" locates 24-hour positions of Low beginning with 1230 GMT, November 4, 1951.

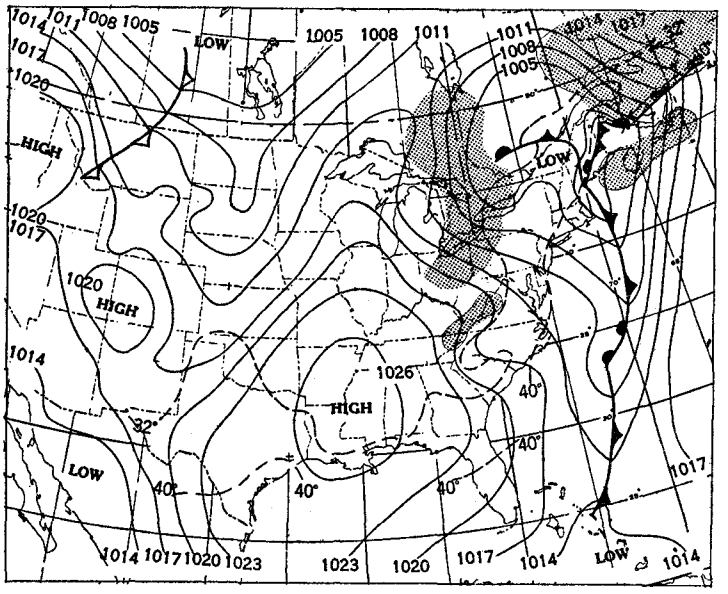

FIGURE 3.—Surface weather chart, 1230 GMT, November 8, 1951. Dotted lines indicate selected isotherms.

ORIGIN OF THE COLD WEATHER

At the surface, cold polar air moved westward across Kansas from the ridge of high pressure to the northeast (fig. 2). Despite the pressure arrangement, the air flow over western Kansas turned sharply left across the surface isobars in reaction to the combined influence of the rising terrain to the west (Colorado and Wyoming) and the area of low pressure near Big Springs, Tex. As time progressed, this blocking and channeling effect of the Rocky Mountains and the increasing influence, upon the circulation, of the deepening Low resulted in a considerable volume of cold air moving southwestward across Oklahoma; eventually it overspread most of Texas. The surface situation was augmented by the deepening trough aloft which continued to transport cold air to more southerly latitudes.

For 15 hours, after the time of figure 2, cold air from the receding ridge continued to drain into the north and west sides of the developing storm. By late evening on the 7th most of Texas was reporting barometer readings above 1,013 mb. After this period the flow of air from the ridge became less important as air from the Colorado-Wyoming region began draining into Oklahoma and western Texas, under the influence of the 700-mb. flow.

It is worth noting that the 700-mb. flow over the portion of the States just west of the Divide is fairly close to the surface of the earth. On the morning of the 6th, the circulation was such that the same isopleth of height above San Antonio, Tex., could be traced through Amarillo, Tex., Denver, Colo., and Casper, Wyo., to the vicinity of Great Falls, Mont. This same morning the surface ridges of high pressure extended along a line from Montana southeastward through Colorado in a narrowing, central isobar-enclosed area which projected down the Rio Grande Valley to Brownsville, Tex. At 1230 GMT, on the 6th a closed center of pressure (1,029 mb.) formed near Del Rio, Tex.

In the following 2 days the storm moved toward the northeast. (See track, fig. 2.) The drainage of cold air, now from the Mountain States, continued to feed into the Texas area without the Del Rio High showing any definite tendency to move far from its point of origin. Finally, the High began to move eastward (see Chart X), increased in size (fig. 3) and was attended by unseasonably cold weather over Texas and the Gulf States (fig. 4). The low temperatures in Missouri were caused, primarily, by radiation abetted by the deep snow cover.

The history of this High and its associated cold weather departed from the usual story of cold surges coming down directly from the Canadian Plains. Instead, in this instance, a High originated over Alberta, Canada, and then moved southward to southeastern Colorado, where it remained almost stationary for a few days. It became so diffuse as to escape detection after the morning position of November 4. (See Chart IX.) However, the cold air mass, which had been imported, remained in the region until it moved out as has been previously discussed.

The increasing size of the ridge once it became migratory is connected with the equatorward motion of cold air on the west side of the trough aloft which flattened in amplitude as it moved northeastward. As the amplitude decreased the air flow above the cold air mass became more westerly resulting in a fanning out of the cold mass to the east.

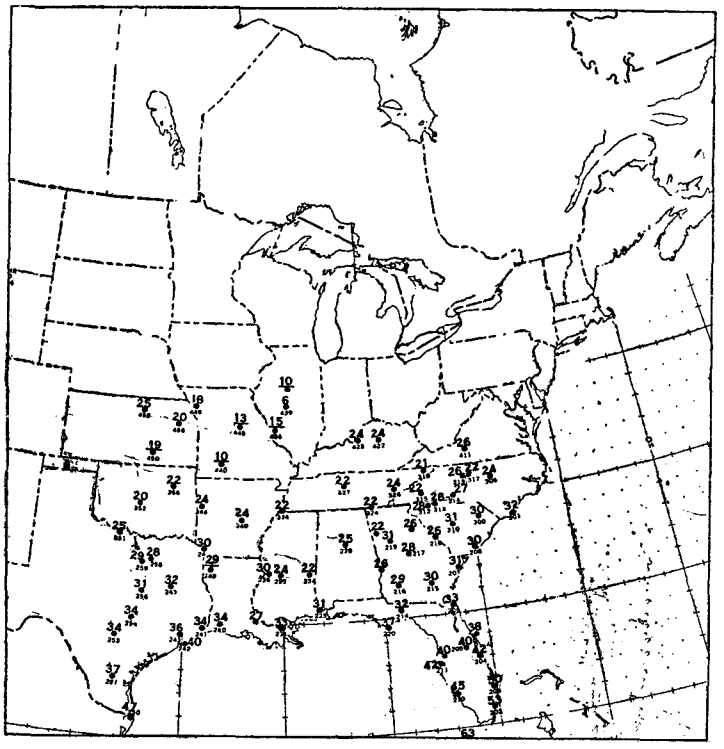

FIGURE 4.—Minimum temperature chart for selected stations during the period November 6–9, 1951. Underlined value indicates new record established.

981509—52——2

THE SNOWFALL

The first indication that "weather" was brewing over the Southwest was the start of a light snowfall over western Kansas as the cold air moved upslope over that State. As the developing storm moved eastward the upslope motion of the cold surface air ceased and, instead, air from the Gulf began moving over the wedge of polar air to supply the necessary moisture. Missouri and Illinois received the brunt of the fall although such regions as the Great Lakes and the Ohio Valley received snow for varying lengths of time before it changed to rain.

The question suggested is why these two States should receive the heaviest falls of snow. Some clues to the answer are already available from the path of the storm (fig. 2) and the fact that it occluded near Evansville, Ind. As the occluded center moved northeastward the surface circulation in advance of its path pulled warmer and warmer air farther north or northwest (west of the Appalachian Mountains) around the advancing front.

In addition, polar air from the ridge along the Atlantic Coastal Plain, becoming increasingly more maritime in character, fed into the strong circulation on the west side of the mountains. This air stream reached farther to the northwest than the air stream from the Gulf. For instance, it was easily traced from its point of entry on the Maryland shore, across Pennsylvania and Ohio, to southern Michigan. The temperature of the air stream over Michigan was in the low to middle thirties. As the storm swept over the Ohio Valley and the lower Great Lakes the snow changed to rain.

The preceding paragraphs are meant to convey the idea that the snow stopped as the continental polar air, which originally had a trajectory from the northeast, changed to a direction from the southeast bringing in more modified air. This becomes quite clear if one surveys the series of maps for the period. In such a survey it becomes apparent that Missouri and Illinois were at all times in the cold polar air. As the upper trough moved into this region the depth of the cold air increased.

The heavy snowfall broke records for depth at a number of stations in the two States. Springfield, Mo., reported 14.1 inches which presumably was of record proportions

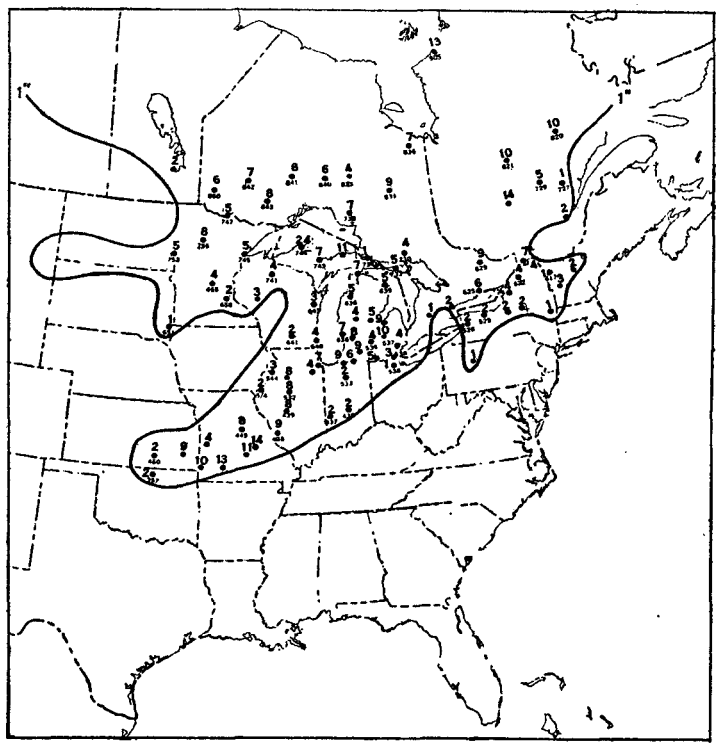

FIGURE 5.—Snow depth chart, 1230 GMT, November 7, 1951, showing the depth of the snow on the ground (in inches) at observation time.

for November although the Station Meteorological Summary did not specifically mention the fact. St. Louis, Mo., recorded 12.5 inches, which was the heaviest November snow fall of the station's history. It ranked as the sixth heaviest fall for St. Louis since 1884, when the records were started. Furthermore, it was the heaviest fall of snow in one storm in 39 years. Springfield, Ill., had its heaviest fall for so early in the season with a measured 8.2 inches. Peoria, Ill., received a record early season fall of 7.8 inches. Columbia, Mo., with 7.5 inches, had the greatest 24-hour fall for any November in its station history. Finally, Wichita, Kans., had 7.5 inches to make it the heaviest fall in any 24 hours and the third greatest snowfall in any November. Figure 5, the snow depth chart for 1230 GMT, November 7, shows representative values for the amount of snow cover during the period of November 6 to 8.

U. S. GOVERNMENT PRINTING OFFICE: 1952